

Fenning (D.) & Probert (J.) R 799

THE
M E T H O D
Of CALCULATING an
E C L I P S E.

GEOMETRICALLY;

WITH AN
E X A M P L E
OF THE

Great ECLIPSE of the SUN, which
will happen on APRIL the 1st, between
nine and ten in the Morning, 1764.

The whole PROCESS being fully laid down,
and plainly demonstrated by a Copper-Plate
of the whole OPERATION.

By D. FENNING,

Author of the ROYAL ENGLISH DICTIONARY, YOUNG
MAN'S BOOK OF KNOWLEDGE, TREATISE ON THE
USE OF THE GLOBES, ARITHMETIC, and the READY
RECKONER, &c.

AND

JOHN PROBERT,

Master of the Academy, Cox's-Square, Spital-Fields.

L O N D O N :

Printed for S. CROWDER, at the *Looking-Glass*,
in *Pater-Noster-Row*.

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Presented by

John W. Mudge

1790

WITH AN
EXPLANATION
OF THE
Great ECLIPSE of the SUN, which
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nine and ten in the Morning, 1764.

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JOHN PROBERT,

Printer of the Academy, Great Street, Strand.

LONDON:
Printed by S. CROWDER, at the Academy,
in Pall-mall, 1790.
MCCXC.

TO THE
YOUNG GEOMETRICIANS,
AND
LOVERS of MATHEMATICAL
LEARNING.
GENTLEMEN,

I. **A**S the Construction of
an Eclipse Geome-
trically is very rarely to be
met with in mathematical
Books: We thought it might
be acceptable to you to lay
A 2 down

down the Proceſs of calculating an Eclipse by Geometrical Conſtruction only, near enough to ſatisfy the Curioſity or Deſire of any Perſon.

2. Whoever of you are acquainted with the Uſe of the Scale of Chords, &c. may follow the whole of this Operation Step by Step; but if you are readily acquainted with the Uſe of that noble Inſtrument the Sector, it will be ſo much the better.

3. You may perform this Operation even with a fix-inch'd Sector; but one of a Foot is better, becauſe the larger

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larger the Scale, no Doubt
but the Work will be the
more exact.

4. We shall only add,
that this Operation has
been performed by various
Scales by both of us ; and we
jointly and separately came
very near to each other.

5. You are to note, that
this Operation is performed
by a nine-inched Sector ; there-
fore by *One* of that Radius you
will be the better able to trace
the Work than by any other.

We are

Your Well-Wishers,

D. F.

AND

J. P.

larger the Scale, no Doubt
but the Work will be the
more exact.
We shall only add,
that this Operation has
been performed by various
Scales by both of us; and we
jointly and separately came
very near to each other.
5. You are to note, that
this Operation is performed
by a transversed Sector; there-
fore by One of that Radius you
will be the better able to trace
the Work than by any other.

We are

Yours Well-Wishers,

D. F.

J. B.

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Geometrical Construction
OF THE
ECLIPSE OF THE SUN,

Which will happen *April 1, 1764.*

Constructed *August 17, 1763.*

REQUISITES for *April 1,*

1. **T**HE true Time of
the New Moon } *1 10 33 25*

2. Semi-diameter of the
Earth's Disk } *— 54 45*

3. The

3. The Sun's Distance from the nearest Solstice	} 77 49 48
4. The Sun's North Declination	} 4 49
5. The Moon's Lat. North ascending	} — 40 18
6. The Moon's horary Motion from the Sun	} — 27 54
7. The Angle of the Moon's visible Path with the Ecliptic	} 5 35
8. The Sun's Semi-diameter	— 16 6
9. The Moon's Semi-diameter	} — 14 53
10. The Semi-diameter of the Penumbra	} — 31 3

OPERATION.

First, Make a Scale of any convenient Length as AC, divide it into as many equal Parts as the Earth's Semi-Disk contains Minutes of a Degree, which

which in this Case, *April* 1, is $54^{\circ} 45'$:
Then with the Length of the whole
Scale as a Radius describes the Semi-
circle ADB upon the Center, which
represents the Northern Parts of the
Earth's enlightened Disk as seen from
the Sun.

Secondly, Upon the Center C, raise
the Perpendicular CD to the Diameter
ACB; let ACB represent Part of the
Ecliptic and CD its Axis.

Thirdly, Take a good Sector, open
it to the Radius CA in the Line of
Chords, and taking the Chord of 23°
 $30'$, set it off both Ways from D to *a*,
and *b* in the Periphery of the Semi-Disk,
and draw the straight Line *aEb*, in which
the North Pole of the Disk will be al-
ways found.

B

Fourthly,

Fourthly, Open the Sector till the Radius (or Distance of the two 90's) of the whole Sines be equal to the Length of Eb , and take the Sine of the Sun's Distance from the Solstice, (*viz.* $77^{\circ} 49' (48'')$) as near as you can in your Compasses from the Line of Sines, and set off that Distance from E to F in the Line Eb , because the Earth's Axis lies towards the right Hand of the Axis of the Ecliptic (in this Case) the Sun being in Aries: and draw the strait Line $CXII F$ for the Earth's Axis of which F represents the North Pole.

Fifthly, To draw the Parallel of Latitude (of any Place, but here) of *London*, or the Path of that Place on the Earth's enlightened Disk, is seen from Sun-rising to Sun-set, proceed as follows—Subtract the Latitude of *London* from $90 =$

38°

38° 30', take this in your Compasses from the Chords (first making CA or CB Radius, and set it from *b* (where the Earth's Axis meets with the Periphery of the Disk) to VI and VI; then from the Point where this Line meets the Earth's Disk, set off the Chord of the Sun's Declination 4° 49' to G and H, and to I and K, and connect these Points by the two occult Lines GLH and I X K.

Sixthly, Bisect G X in L, and thro' L draw the Line VI L VI. Then making CB the Radius of a Line of Sines on the Sector, take the Co-latitude 38° 30' from the Sines, and set it both Ways from L to VI and VI by Way of Trial—These Hours will be just at the Edge of the Disk at the Equinoxes but at no other Time in the Year.

Seventhly, Take the Extent L VI in your Compasses (in the Sine below the occult one as a Center) and one Foot being in L, with the other describe the Semicircle VI 12 VI, and divide it into 12 equal Parts; then from these Points draw Lines 1, 1; 11, 11; 2, 2; 10, 10; 3, 3; 9, 9; 4, 4; 8, 8; 5, 5; and 7, 7; all parallel to the Earths Axis, 12 XII F.

Eighthly, With the small Extent L XII as a Radius, describe the quadrantal Arch L XII-C, and divide it into 6 equal Parts, and through the Points draw the Lines VII, V; VIII, IV; IX, III; X, II; XI, and I, parallel to VI, VI; connect these Points together by a curve Line drawn from the Center XII, through all these Points will shew the ecliptical Curve and several Situations of the Path of London on the Earth's Disk, but these Hours respectively as seen from the Sun,

and

and the ecliptic Curve VI, VII, VIII, &c. being drawn through these Points, shall represent the Parallel of Latitude or Path of the Disk as seen from the Sun, from his rising to setting.

Ninthly, Make CB the Radius of a Line of Chords on the Sector, and taking from thence the Chord of $5^{\circ} 35'$ the Angle of the Moon's visible Path with the Ecliptic, set it off from D to M, on the Left-Hand of D the Axis of the Ecliptic, because the Moon's Latitude is North ascending—Then draw CM the Axis of the Moon's Orbit, and bisect the Angle MCD by the right Line Cde.

Tenthly, Take the Moon's Latitude $40^{\circ} 18'$ from the Scale CA in the Compasses, and set it from *f* to *d* in the bisected Line

Line Ca , making sd parallel to Cg , and then at right Angles to the Moon's Orbit OM draw the straight Line Pds for the Path of the Center of the Penumbra over the Earth's Disk—The Point b is that where the Penumbra's Center approaches nearest to the Earth's Disk, and consequently is the Middle of the Eclipse itself in general: The Point d is where the Conjunction of the Sun and Moon falls according to the Tables, and the Point g is the ecliptical Conjunction of Sun and Moon.

Eleventhly, Take the Moon's true horary Motion from the Sun $27' 54''$ in your Compasses from the Scale CA (every Division of which is a Minute of a Degree) and with it make Marks along the Path of the Penumbra's Center, and divide each Space from Mark to Mark into 60 equal Parts (which will be horary

rary Minutes) by Dots, and place the Hour to every 60th Minute in such a Manner, that the Dot signifying the Instant of New Moon by the Tables may fall upon the Point *d*, Half-way between the Axis of the Moon, and the Axis of the Ecliptic, and then the other Dots in Order will shew the Points on the Earth's Disk where the Penumbra's Center is at the very Instant denoted by them in its Transit over the Earth.

Twelfthly, Apply one Side of a true Square to the time of the Penumbra's Path, and move the Square backwards and forwards, till the other End of it cuts the same Hour and Minute, both in the Path of *London*, and the Path of the Penumbra's Center, at the perpendicular Line *mn*, and that particular Minute that the Square cuts at the same Time in both Paths, will be the very Instant of the
visible

visible Conjunction of the Sun and Moon, or the very Middle of the Eclipse itself at any Place for which such Construction is made, which here is *London*; and this Middle in the Case before us will be about 47 Minutes past 10 in the Morning, which is some Minutes later than the tabular Time of true Conjunction.

Thirteenthly, Take the Sun's Diam. 16' 6" in the Compasses from the Scale CA, setting one Foot in the Path of *London* at a Point where *nn* cuts VI VI (*viz.* at 47'. past 10 in the Morning) with the other Foot describe the Circle SS, SS, which shall represent the Sun, as seen from *London* at the Middle of the Eclipse — This done, take the Moon's Semidiameter 14'. 54". in your Compasses from the aforesaid Scale, and setting one Foot in the Point where *nn* cuts the

Path

Path of the Penumbra's Shadow (*viz.* at 47'. past 10, as aforesaid) with the other Foot describe the Circles MM for the Moon's Disk, as seen from *London* the Middle of the Eclipse, or Time of the greatest Obscuration, and the Portion of the Sun's Disk hid or cut off by the Moon's will shew the Quantity eclipsed at that Time, which may be measured on any Scale or Line made equal to the Diameter of the Sun divided into 12 Parts, which in this Case will be 11 Parts or Digits.

Lastly, Take the Semidiameter of the Penumbra 31'. 3". from the Scale CA in the Compasses, and setting one Foot in the Line of the Penumbra's central Path, on the Left-hand from the Axis of the Ecliptic, turn the other Foot towards the Path of *London*, carrying that Extent backwards and forwards, till both

C

the

the Points of the Compasses fall upon the same Instants in both Paths, and these Instants will denote the very Time when the Eclipse begins at *London*, viz. PQ. — Do the like on the Right-hand of the Axis of the Ecliptic, where the Points of the Compasses will fall into the same Instants in both Paths, it shews what Time the Eclipse ends at *London*, against RS, which is about 18 past 12.

These TRIALS give about 21 Min. past Nine in the Morning for the Beginning of the Eclipse at *London* in the Points P and Q; 47 past 10 for the Middle in the Line *mn*, as before directed, viz. the Middle of the Eclipse; and 18 Minutes past 12 at R and S the End of its Continuance, 2 Hours 57 $\frac{1}{2}$ Minutes.

F I N I S



*A Geometrical Construction of the Eclipse of the Sun, which
will happen about $\frac{1}{2}$ past 10 on April, 1.st 1764. Constructed Aug^r 17. 1763.*

By D.F. and J.P.

Begins	Mid	Ends	Dur	Dig
h ' "	h ' "	h ' "	h ' "	h ' "
9.21.0	10.47	12.18	2 57	11

*By some Tables this is 17 Min. by others 15'
by others but 6. more, or later than the Astronomers
Calculations.*

